

INDOOR AIR QUALITY ASSESSMENT

**Attleboro Fire Department, Briggs Corner Station
1276 Park Street
Attleboro, Massachusetts**



Prepared by:
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Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of James Mooney, Director of the Attleboro Health Department, an indoor air quality assessment was conducted at the Attleboro Fire Department (AFD), Briggs Corner Station located at 1276 Park Street, Attleboro, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH). On December 16, 2005, a visit to conduct an indoor air quality assessment was made to the Briggs Corner Station by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. The assessment was prompted by occupant concerns of potential mold growth in the building. The assessment occurred on a windy day during moderate to heavy rainfall.

The station, which was constructed in 1969, consists of a one-story cinder block building connected to an engine bay. The building has undergone several interior renovations over the years. The station contains storage areas for fire fighting equipment, a carpeted bunkhouse for overnight staff, a bathroom, a kitchen and a mechanical room that contains the furnace, water heater and an emergency generator. Windows are openable throughout the building. The engine bay has two garage doors that allow access for fire-fighting apparatus.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor. MDPH staff also performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials (e.g., carpeting, ceiling tiles) was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The station is staffed 24-hours a day, seven days a week and has an employee population of 8 (2 per shift). The station can be visited by up to 5 members of the public on a daily basis. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in all areas surveyed, indicating poor air exchange. It is important to note that the station does not have any means of mechanical ventilation, but uses windows to introduce fresh air. All windows were closed during the assessment; therefore, no outside air was being provided. During the assessment, the emergency generator was activated; the generator can produce carbon dioxide, as well as other products of combustion.

A vehicle exhaust ventilation system that is installed in the engine bays removes carbon monoxide and other products of combustion. The system is described in detail under the Vehicle Exhaust portion of this report.

The Massachusetts Building Code requires that each area have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the

adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see [Appendix A](#).

Temperature readings in occupied areas were measured in the range of 63° F to 74° F. Temperatures readings were within MDPH recommended comfort range in all areas, except the kitchen. The temperature of 63° F was measured in the kitchen, where a door leading to the engine bay was pegged open to allow free flow of air from the cooler engine bay into the kitchen. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measurements in occupied areas ranged from 42 to 60 percent, which were within the MDPH recommended comfort guidelines. The MDPH recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in

the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As mentioned, the assessment was prompted by occupant concerns of mold growth. In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. The assessment was conducted on a windy day of moderate to heavy rainfall.

One area in the kitchen had water-damaged ceiling tiles (Picture 1). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a moisture source or leak is discovered and repaired. MDPH staff removed the tiles to examine the ceiling plenum. The plenum was dry and no visible mold growth or associated odors were found at the time of the assessment. In addition, MDPH staff conducted moisture testing of water damaged ceiling tiles. All water damaged ceiling tiles tested were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment. MDPH staff also examined conditions directly outside the station in this area and observed loose flashing (Picture 2) that may serve as a source of water penetration under certain wind/weather conditions.

MDPH staff observed peeling paint on cinderblock in the bunkhouse, which may also be a sign of water penetration. MDPH staff removed ceiling tiles in this area as well and found no

sings of current water penetration, visible mold growth or odors. Interior walls, window systems and carpeting was also closely examined and found to be dry with no evidence of water penetration. MDPH staff conducted moisture testing of carpeting in this area along the exterior walls, which were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment.

Another potential source for water penetration is through damaged exterior cinderblock (Picture 3), which were found in a few areas. Over time, freezing and thawing can undermine the integrity of the building envelope and provide a means of water entry into the building through concrete and masonry.

Vehicle Exhaust

Under normal conditions, a firehouse can have several sources of environmental pollutants present from the operation of fire vehicles. These sources of pollutants can include:

- Vehicle exhaust containing carbon monoxide and soot;
- Vapors from diesel fuel, motor oil and other vehicle liquids which contain volatile organic compounds;
- Water vapor from drying hose equipment;
- Rubber odors from new vehicle tires; and
- Residues from fires on vehicles, hoses and fire-turnout gear.

The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide, carbon dioxide, water vapor and smoke. Of these materials, carbon monoxide can produce immediate, acute health effects upon exposure. The MDPH established a corrective

action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within the rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for exposure to carbon monoxide in outdoor air. Carbon monoxide levels in outdoor air must be maintained below 9 ppm over a twenty-four hour period in order to meet this standard (US EPA, 2000). *Carbon monoxide should not be present in a typical, indoor environment.* If it is present, indoor carbon monoxide levels should be less than or equal to outdoor levels. The only area with a measurable level of carbon monoxide (1 ppm) was in the mechanical room; this measurement was taken while the emergency generator was operating (Table 1). Outdoor carbon monoxide concentrations were non-detectable or ND.

The local exhaust system for the engine bay consists of a series of ducted exhaust vents running across the ceiling of the engine bay. These ducted vents are connected to a large exhaust motor on the exterior wall of the engine bay and cuff directly onto the tailpipe of fire engines (Pictures 4 and 5). Although the engine bay is equipped with a mechanical ventilation system, a number of pathways for vehicle exhaust and other pollutants to move from the engine bay into occupied areas were identified.

The kitchen door to the engine bay is typically propped open (Picture 6), allowing diesel exhaust and associated particulates to move from the engine bay into occupied areas of the station. In addition, the doorknob to the kitchen was removed, leaving a hole through the door (Picture 7). The mechanical room and bunkhouse doors had spaces beneath/around them from which light could be seen penetrating; these spaces can serve as pathways for diesel exhaust and

particulates into occupied areas.

Another possible pathway for exhaust emissions is through utility holes. The ceiling/walls of the engine bays (and mechanical room) are penetrated by holes for utilities (Pictures 8 and 9). If they are not airtight, these holes can present potential pathways into occupied areas.

Each of the aforementioned conditions present a pathway for air to move from the engine bay and mechanical room to occupied areas of the station. In order to explain how engine bay pollutants may be impacting adjacent areas, the following concepts concerning heated air and creation of air movement must be understood.

- ◆ Heated air will create upward air movement (called the stack effect).
- ◆ Cold air moves to hot air, which creates drafts.
- ◆ As heated air rises, negative pressure is created, which draws cold air to the equipment creating heat (e.g., vehicle engines).
- ◆ Combusted fossil fuels contain heat, gases and particulates that will rise in air. In addition, the more heated air becomes the greater airflow increases.
- ◆ The operation of HVAC systems (including rest room exhaust vents) can create negative air pressure, which can draw air and pollutants from the engine bays.

Each of these concepts influences the movement of odors from the engine bay to adjacent areas.

As motor vehicles operate indoors, the production of vehicle exhaust in combination with cold air moving from outdoors through open exterior doors into the warmer engine bays can place the garage under positive pressure. Positive pressure within the garage will force air and pollutants through spaces around doors, utility pipes and other holes in walls, doors and ceilings. To reduce airflow into adjacent areas, sealing of these pollutant pathways should be considered.

Other IAQ Evaluations

Exposed insulation material was observed on two pipes in the mechanical room (Picture 10). The pipe insulation most likely is an asbestos containing material. Prior to leaving the station, MDPH staff contacted Deputy Fire Chief Erik Guillette and recommended that the insulation be re-wrapped by a licensed asbestos remediator as soon as practicable.

Finally, window-mounted air conditioners (AC) are reportedly used to provide cooling during spring/summer months. MDPH staff inspected these AC units and found the cooling coils had accumulated dust and debris (Picture 11). The addition of moisture to the accumulated debris in the cooling coils can provide conditions for mold growth, which can be aerosolized when the AC units are activated.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Replace water damaged ceiling tiles. Monitor the kitchen and the bunkhouse areas for leaks and repair any water leaks as they may occur. Have flashing above this area at the kitchen/engine bay junction inspected for proper installation/function.
2. Replace kitchen door to engine bay. Ensure all doors accessing the engine bay are closed at all times.
3. Ensure doors around engine bay and mechanical room fit completely flush with threshold. Seal doors on all sides with foam tape, and/or weather-stripping.
Consider installing weather-stripping/door sweeps on both sides of doors with

- access to the engine bay to provide a dual barrier. Ensure tightness of doors by monitoring for light penetration and drafts around doorframes.
4. Ensure all utility holes are properly sealed in the engine bay and mechanical room and at their terminus to eliminate pollutant paths of migration.
 5. Clean/change filters for AC units as per the manufacturer's instructions or more frequently if needed. Clean cooling coils of dust and debris prior to activation.
 6. Use openable windows as designed to increase air exchange.
 7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
 8. Remove or remediate damaged pipe insulation in mechanical room in conformance with Massachusetts asbestos remediation and hazardous waste disposal laws.
 9. Seal/repair damaged masonry on the exterior of the building to prevent water penetration, drafts and pest entry.
 10. Consider cleaning carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

11. Consult “Mold Remediation in Schools and Commercial Buildings” published by the US EPA (2001) for further information on mold. Copies of this document can be downloaded from the US EPA’s website:
http://www.epa.gov/iaq/molds/mold_remediation.html.
12. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH’s website: http://mass.gov/dph/indoor_air

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Picture 1



Water Damaged Ceiling Tiles in Corner of Kitchen near Exterior Door

Picture 2



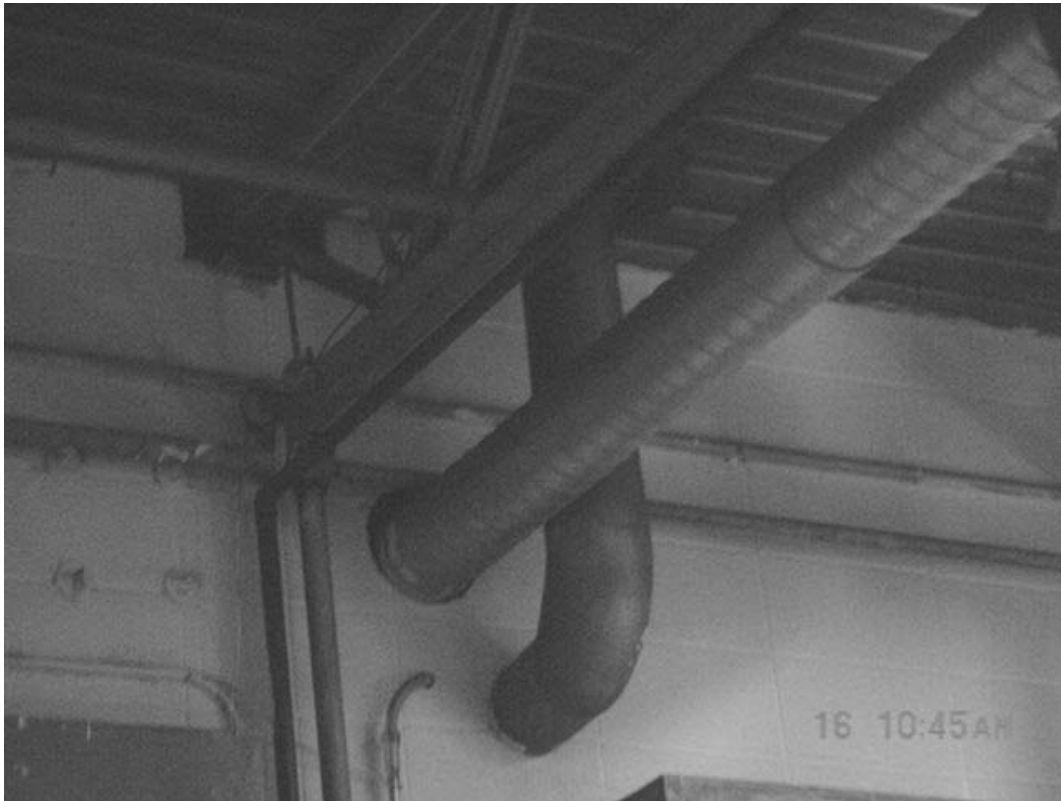
Loose Flashing between Station Roof and Engine Bay near Water Damaged Ceiling Tiles in Kitchen

Picture 3



Damaged Exterior Block

Picture 4



Exhaust Terminus outside the Building for the Local Exhaust Ventilation System

Picture 5



Pressurized Cuff on Tailpipe for Local Exhaust System

Picture 6



Kitchen Door to Engine Bay Propped Open

Picture 7



Hole in Engine Bay/Kitchen Door Where Doorknob was Removed

Picture 8



Utility Hole in Common Wall between Bunkhouse and Engine Bay

Picture 9



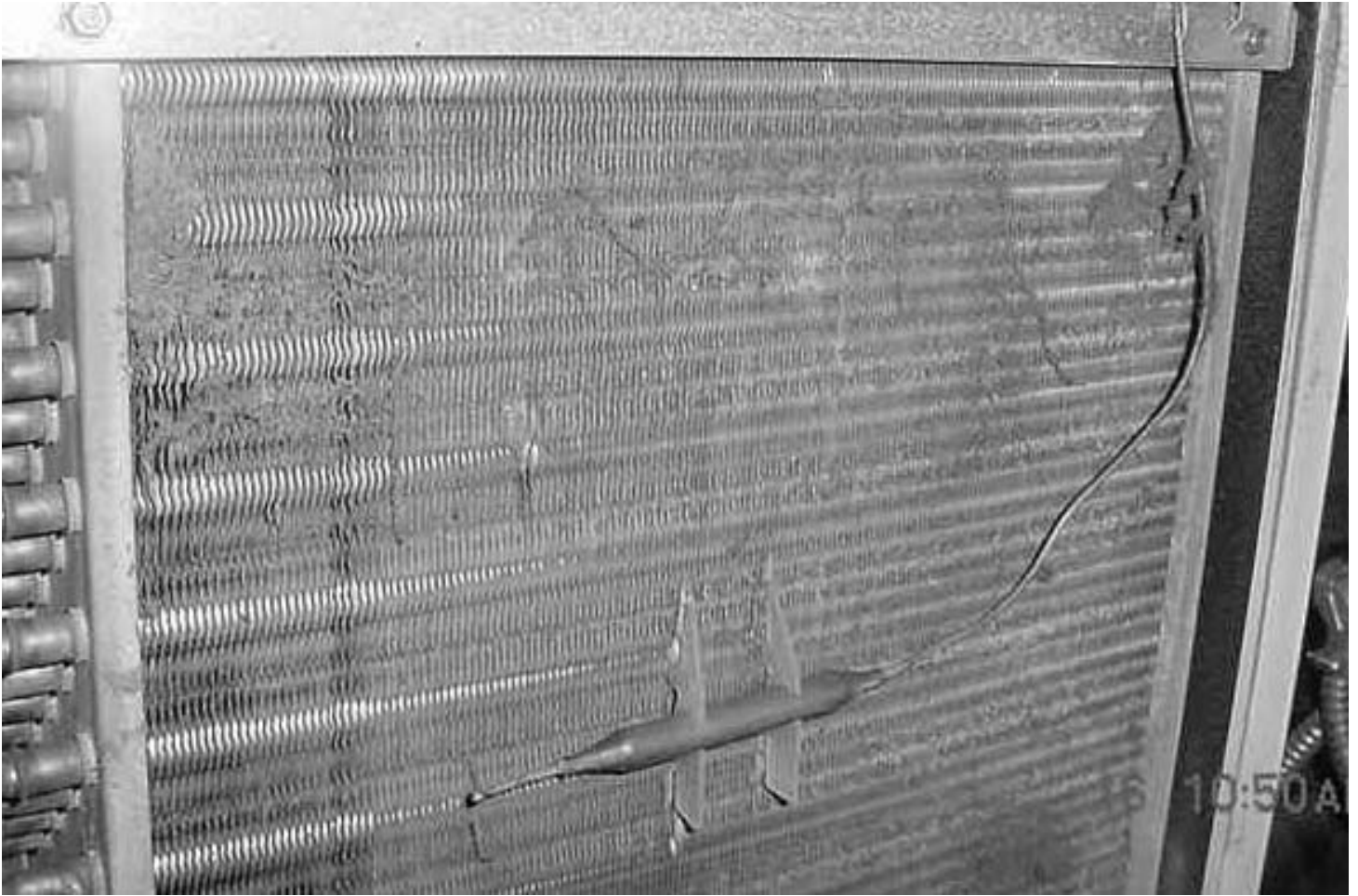
Utility Hole for Pipes in Mechanical Room

Picture 10



Exposed Insulation Material in Mechanical Room

Picture 11



Accumulated Dust and Debris in Cooling Coils of AC Unit

TABLE

Indoor Air Test Results – Attleboro, Briggs Corner Fire Station

December 12, 2005

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp °(F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
Background	383	ND	46	95					Moderate to Heavy Rain, East winds 15-25 mph
Kitchen	1044	ND	63	60	1	Y	N	N	Low (normal) moisture content in water damaged ceiling tiles, gas stove, door propped open to engine bay, hole in door-handle removed
Engine bay	873	ND	63	60	0	Y	N	N	Local exhaust system
Mechanical room	1156	1	74	51	0	N	N	N	Emergency generator operating, exposed pipe insulation, spaces around/under door
Bunk room	1211	ND	71	42	1	Y	N	N	Peeling paint corner of wall near ceiling, low (normal) moisture content in ceiling tiles and carpeting along exterior walls, spaces under door to engine bay, open utility hole to engine bay,
Restroom	1271	ND	72	42	0	Y	N	Y	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%